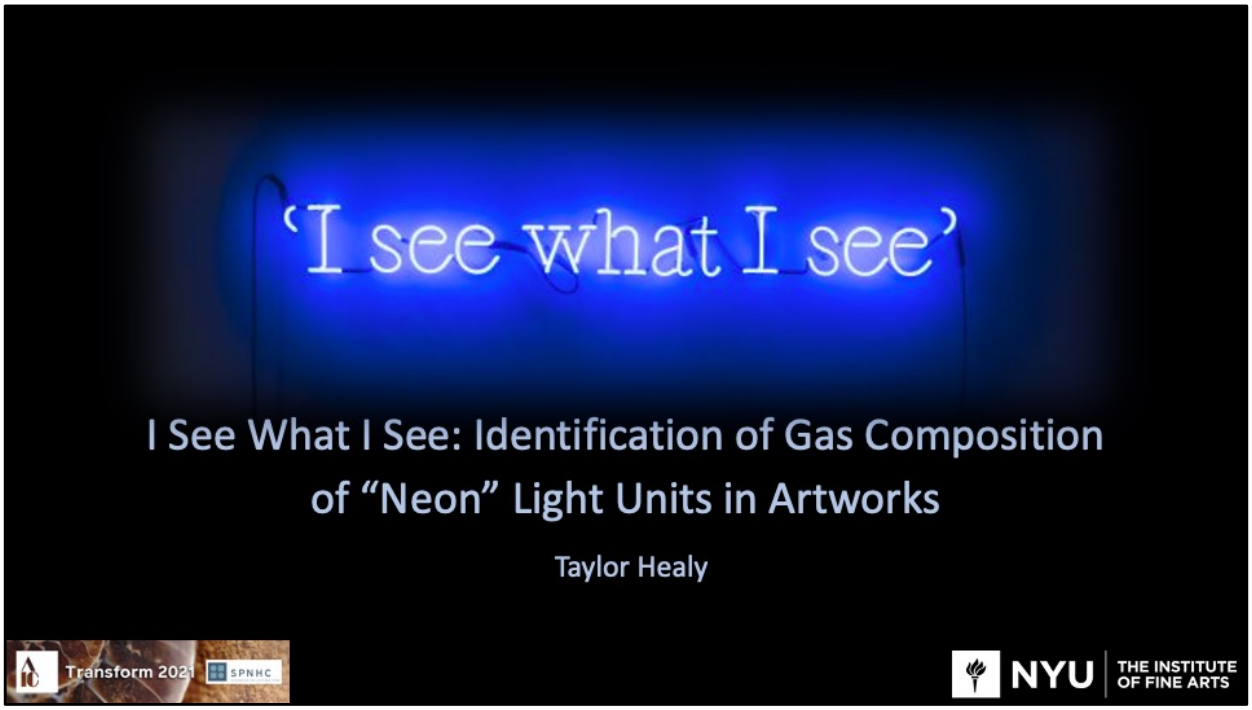
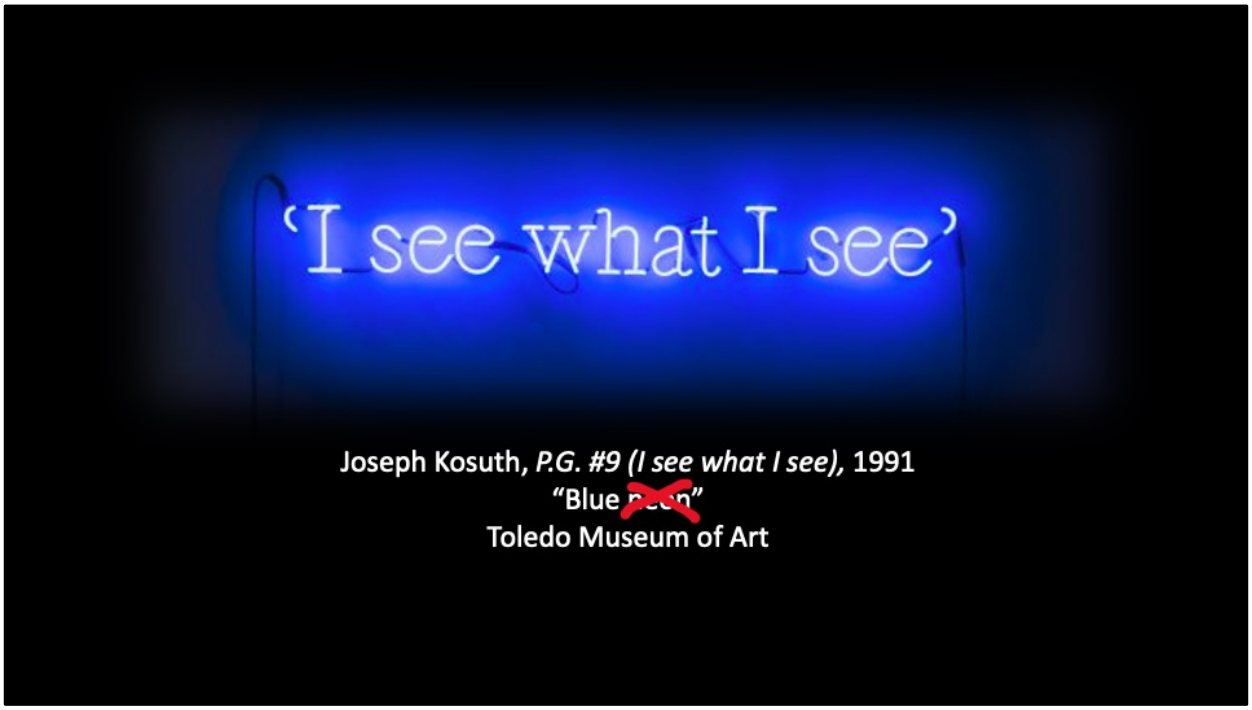


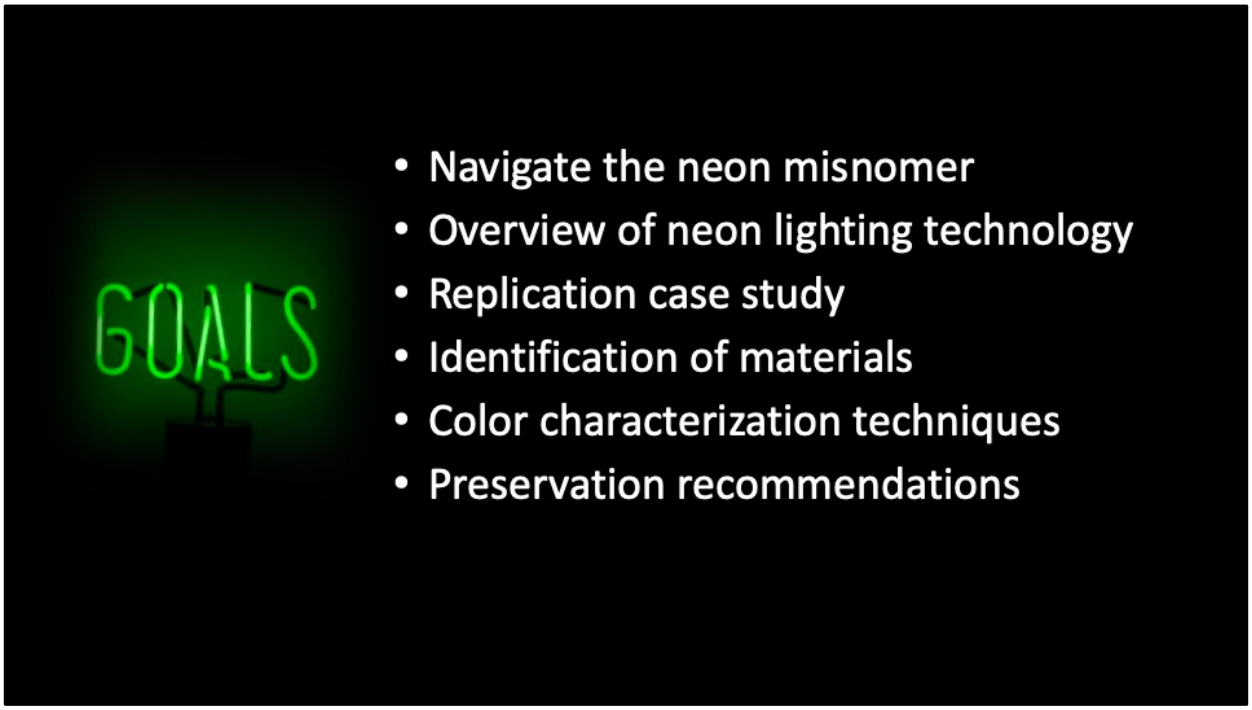
https://drive.google.com/file/d/1Fxqjndemn4cIEMyAietit1KiVZAka9Wr/view?usp=sharing

If you have trouble hearing me, please feel free to interrupt. I can't see the chat or see anyone in the zoom so if there aren't any issues I will begin. The title of this presentation refers to a language-based light artwork created by Joseph Kosuth where the phrase *I See What I See* is fabricated in what the artist called "blue neon". Like his other light installations this is a work that he considers as a reflection on its own construction…

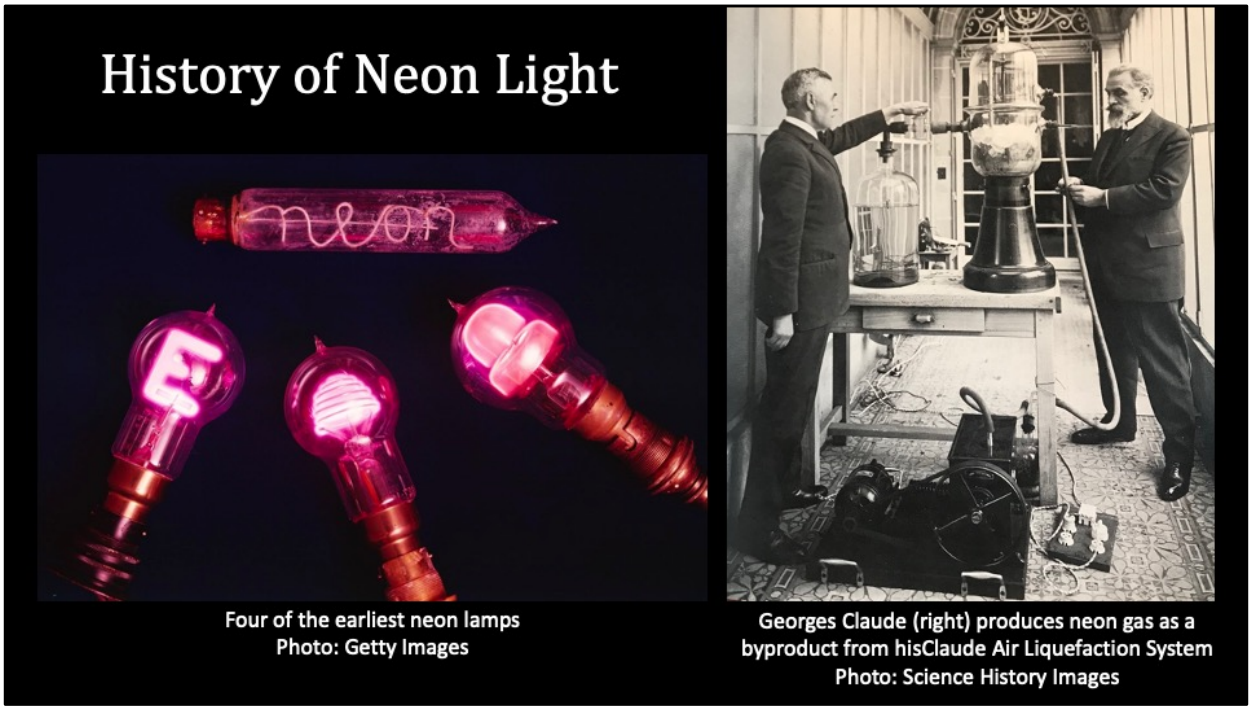


Joseph Kosuth, *P.G. #9 (I see what I see)*, 1991
"Blue ~~neon~~"
Toledo Museum of Art

However, this artwork does not contain neon gas. Instead, the cool blue glow was achieved by electrifying a different gas sealed within glass tubes. So we aren't really seeing what Kosuth says we see! CLICK
This class of artworks and signs that we refer to as neons actually derive their color from a variety of gases– making the term neon a misnomer.
What's at stake here? Well, we will see that the color of light is dependent on the type of gas inside glass tubes. Therefore misleading media lines make it difficult for collections care professionals to implement proper maintenance and preservation strategies. What you will take away from this presentation is the ability to accurately document the color of light and identify gases used in these artworks and historical signs



At AIC Two years ago, conservator Sonia Kata presented a brilliant restoration of a neon sign in the Musee McCord collection. She talked about her challenges with identifying the original materials from just two small surviving fragments of the sign. Today, I'll be expanding upon her work by navigating this neon misnomer through its history and technology. I will discuss issues with replacing failed light units with case studies and introduce a technique I developed to identify the gases sealed within these bent glass tubes and the colors they produce– as camera sensors are unable to consistently capture this . Ultimately, these will inform preservation strategies for these light installations.



Let’s begin with the history of Neon lighting technology.
Engineer, chemist, and inventor Georges Claude, pictured on the right, is responsible for introducing neon lights as we know it today. On the left we see some of the earliest neon tubes illuminated. The first glass tubes contained neon gas to produce colored light, and the name “neons” stuck for sake of ease, but we will see that other gases would be used in glass tubes to create different colors of light.

**
Claude initially patented his gas-filled tubes to exploit the neon byproduct created by his air liquefaction system. By applying an electrical charge to a sealed glass tube of neon gas, he was the first to create the neon gas-discharge tube. He debuted his dazzling reddish-orange lamps at the Paris Motor Show in 1910.

Four of the earliest neon lights are shown here (counter-clockwise from top) and include a neon lamp of about 1922; an Osram `Glimmelamp'; a lamp shaped to show a letter 'E';; and a beehive-type neon lamp.

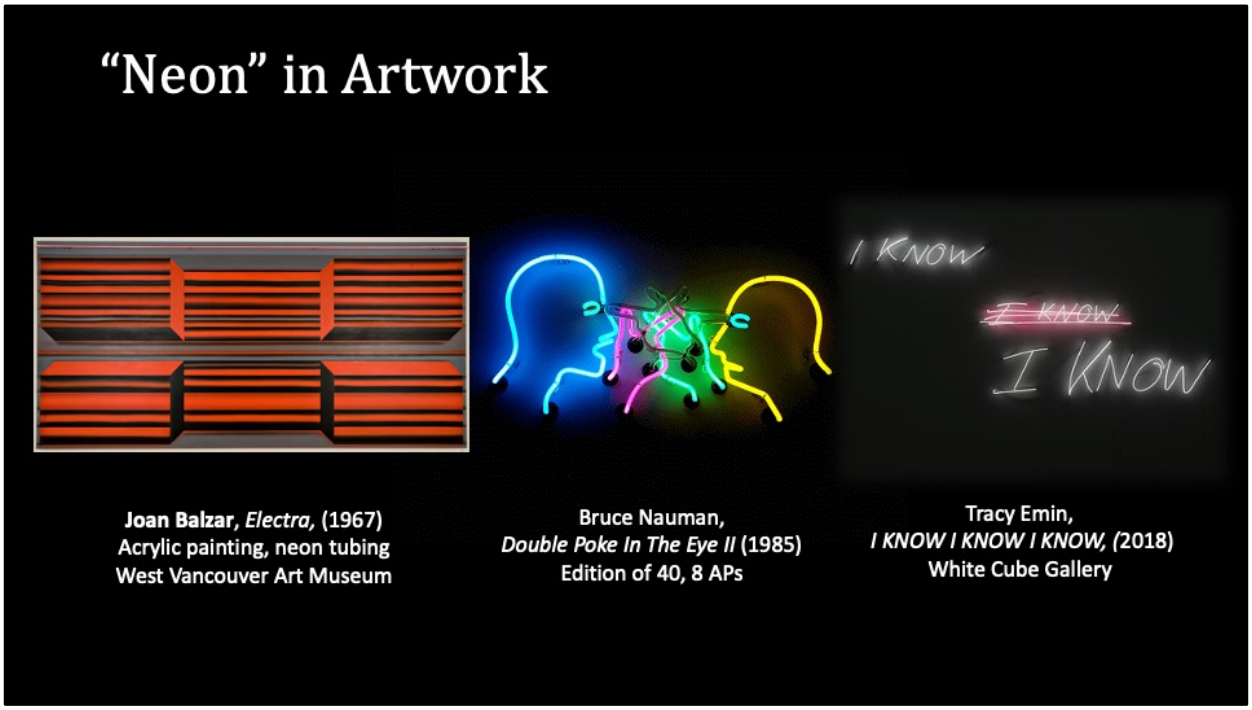
Air liquefaction and synthesis of neon byproduct: Sir William Ramsay (1898) discovered neon by chilling a sample of the air to a liquid phase, warming the liquid,

and capturing the gases as they boiled off. Krypton and xenon were also discovered through this process.

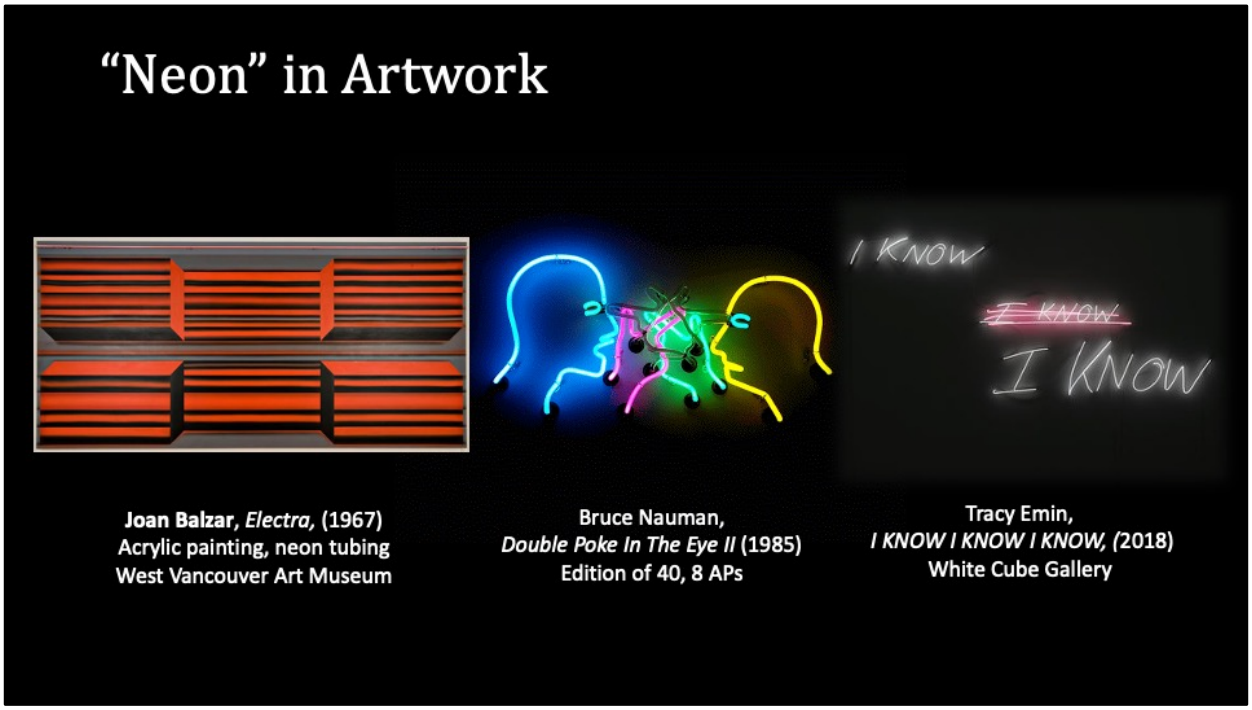
**TRIM THIS
**establish envelope as a vocab words – define bc I want to standardize

Within just five years of Claude's neon debut in Paris in 1910, neon lights were incorporated in architectural elements and advertising signage. The reddish orange glow of neon proved to be highly visible from great distances even in daylight, making them marketing's most **ubiquitous** tools throughout the 20th century. The most notable innovation came with the introduction of different colored tubes, fluorescent coatings, and other noble gases. And if we dust off our middle school chemistry, we remember that noble gases are a group of elements characterized by their chemical stability and also their ability to conduct electricity. Varying combinations of materials allowed for more colorful options– like we see in the russ and daughters sign on the right.

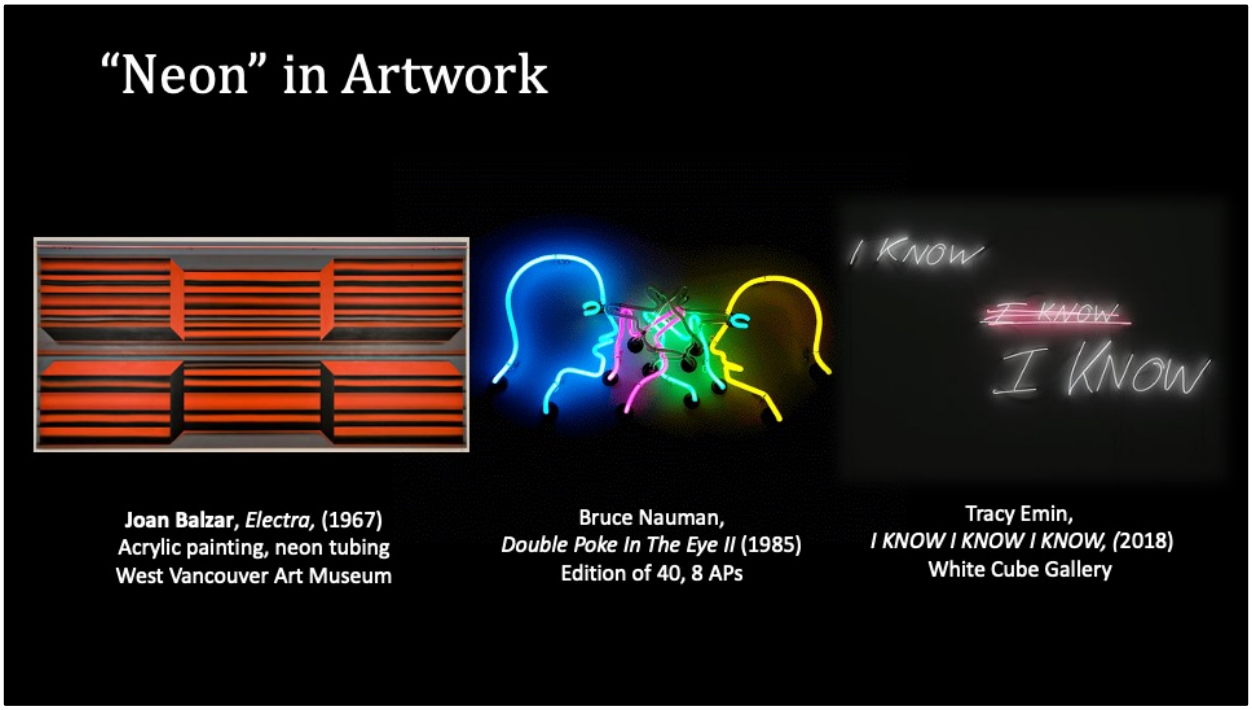
**More on Russ and Daughters refabrication:
https://www.newyorker.com/video/watch/lox-and-neon-at-russ-daughters-new-café



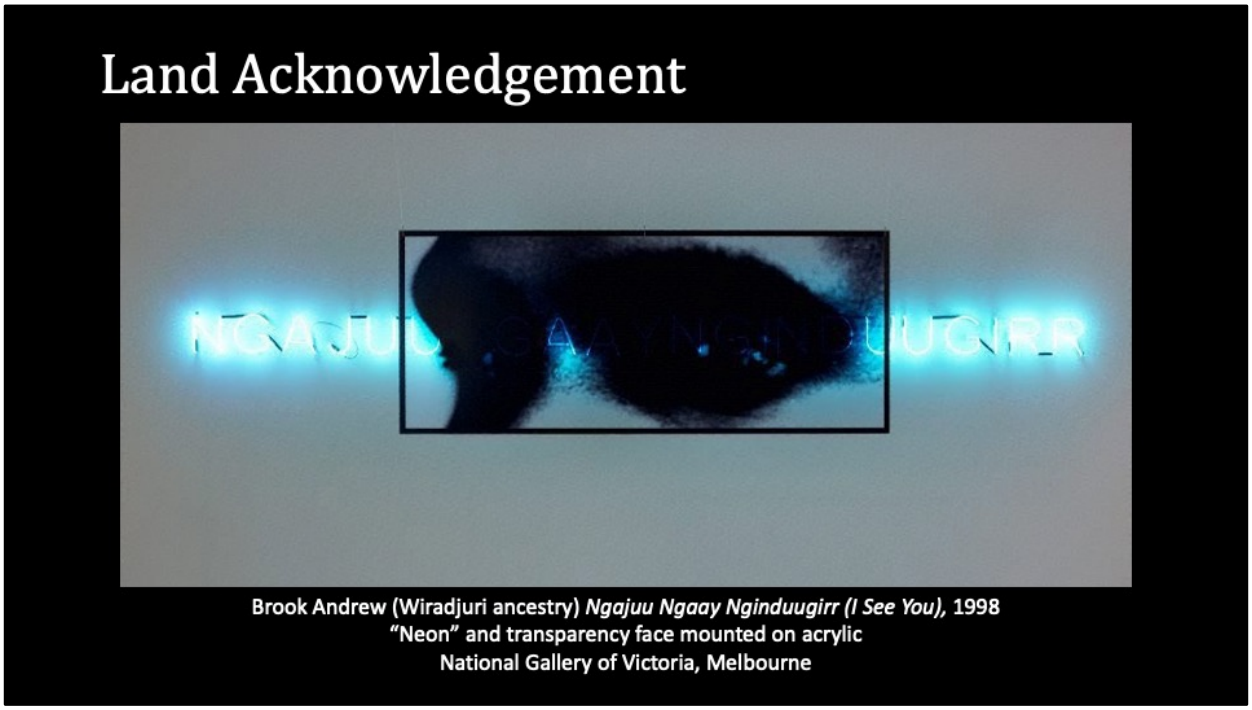
Thankfully neon's artistic, charming, and distinct visual effects were not completely lost after its application for advertising phased out. Just like any technology, it was adapted and used by artists. Artists were drawn to the range of shapes and colors made possible by this media.
Here are just a few examples: Early neon artist joan balzar incorporates neon tubes in her vibrant acrylic paintings. CLICK



Then there's Bruce Nauman's popular animated installations PAUSE



and Tracy Emin's powerful phrases bent in glass and illuminated. PAUSE



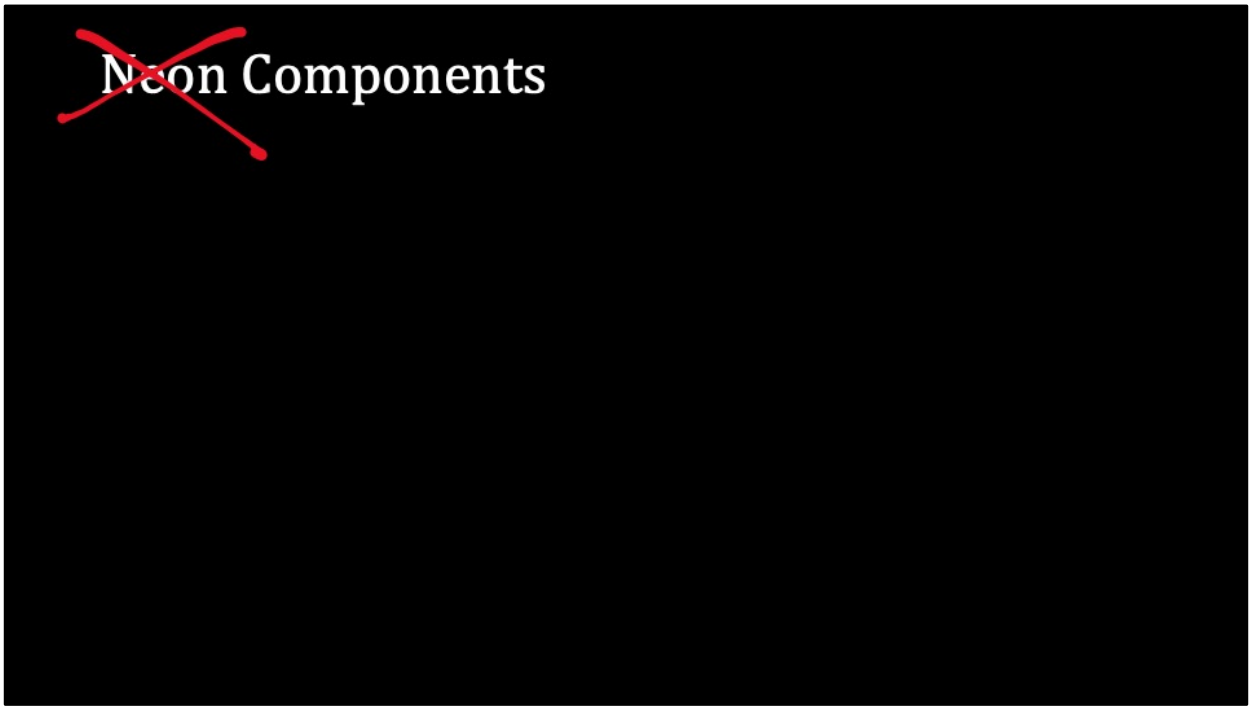
Before I move on, I would like to take this time and acknowledge I am speaking to you all from Washington, DC which is the traditional territory of Anacostan Pamunkey Piscataway and Rappahanock people. I ask you to join me in acknowledging your local communities, their elders both past and present, as well as future generations. Artworks are one of the most powerful ways to communicate histories, reflect ideas, and inspire change. I highlight this text based work by an artist of aboriginal heritage. Brook Andrew The words illuminated in bright blue translate to "I see you" coincidentally similar to Kosuth's but in this case addresses a history of conflict and erasure of indigenous culture.

With the horrifying discovery of remains of First nations children in Canada last week, we have a responsibility to end to systems that perpetuate violence against indigenous communities. Land acknowledgements are just the first step. I support the land back movement as a path to dismantle white supremacy and achieve justice for Indigenous people through the restoration of ecological health and the actual reclamation of Indigenous land and cultural objects.

**

For more information on the landback movement: https://landback.org and

https://grist.org/fix/indigenous-landback-movement-can-it-help-climate/



So what are these dazzling light units made of and how do artists make them? Since, neon is actually a misnomer, CLICK from this point forward, I will be referring to these units by their more accurate term

Gas-Discharge Tube Components

gas-discharge tubes– a class of light sources includes what we referred to as neons

Gas-Discharge Tube Components

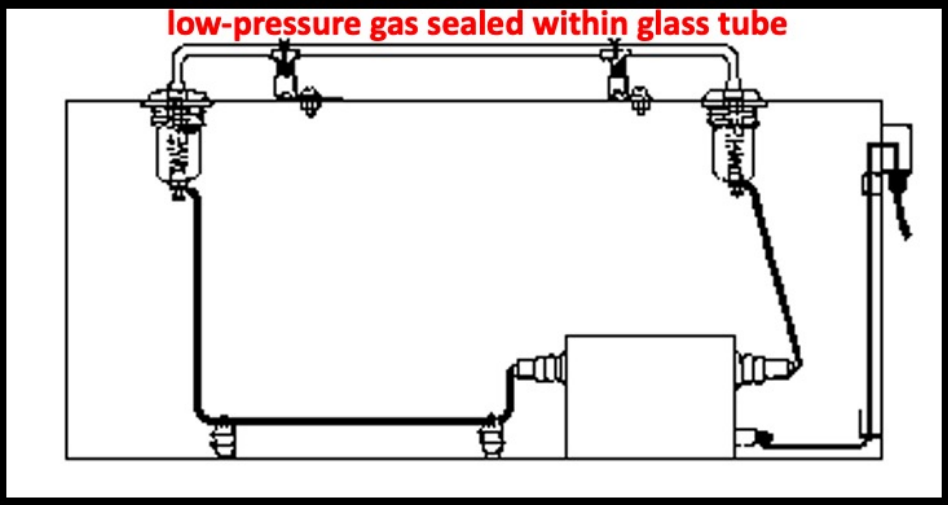


Diagram of a typical cold-cathode gas-discharge tube unit system

Since this technology has remained virtually unchanged since its invention, every gas-discharge tube used in a sign or artwork is comprised of 3 components: CLICK A bent glass tube filled with a noble gas,

Gas-Discharge Tube Components

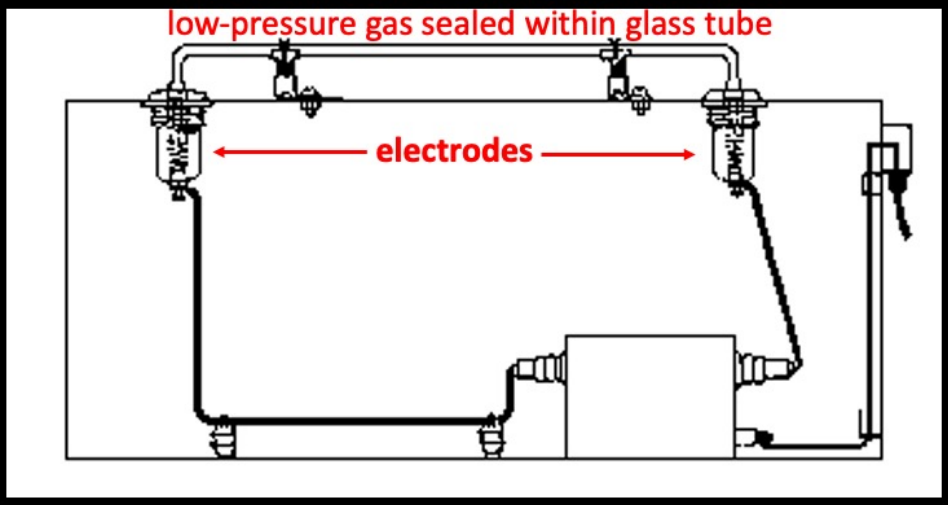


Diagram of a typical cold-cathode gas-discharge tube unit system

electrodes spliced at each end of the glass tube PAUSE

Gas-Discharge Tube Components

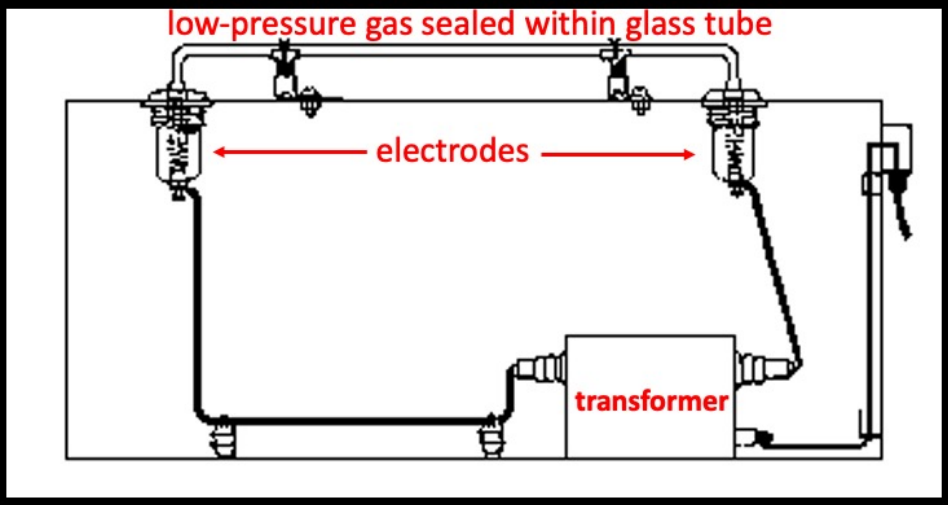
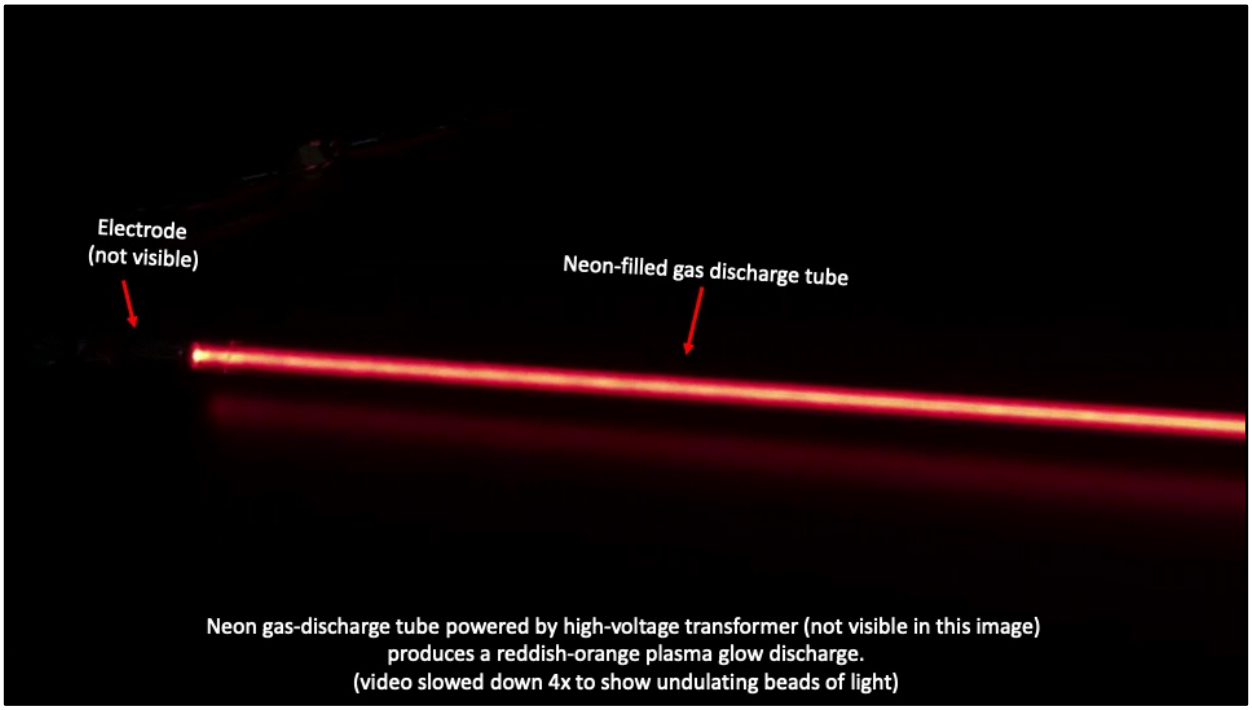


Diagram of a typical cold-cathode gas-discharge tube unit system

and a high voltage transformer.

Units can include other components such as dimmers, flashing switches, and other electronics to further animate the units, but are ultimately not essential to the functionality of tube units.



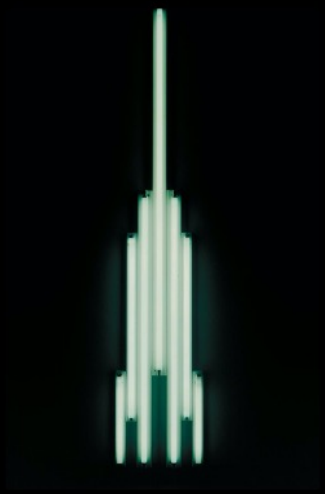
The transformer supplies high voltage to the gas-discharge tube unit, instantly striking an arc between the electrodes which brings the gas to a state of excitation. The excited gas ions collide with electrons and release photons. If you look closely, it appears to us as a colored plasma glow discharge!

**

For detailed information on how gas-discharge tubes work:
https://youtu.be/zPDoBjlpxXY

Other Gas-Discharge Tubes

Navid Nuur, *Untitled* (2014)
Argon+mercury gas fill, lightbulbs
Photo: Galerie Max Hetzler



Dan Flavin, 'Monument' for V. Tatlin (1966–9)
Fluorescent tubes and metal
© ARS, NY and DACS, Tate, London 2019.

Sometimes gas-discharge tubes don't really look like traditional units… On the left we see an artwork by Navid Nurr with two spliced incandescent bulbs replacing a traditional bent glass tube. The electrodes are exciting the gas fill within, bypassing the tungsten filament, making this a gas-discharge unit in disguise. CCFLs or Fluorescents, are also Cold Cathode gas discharge tubes, so a lot of what I talk about today can be applied to light installations with fluorescents!

Fabrication

Using a ribbon burner to bend a glass tube during a fabrication workshop at Brooklyn Glass

What sets this type of gas-discharge tube from commercial fluorescent tubes and many other light sources, is the fact that they are all handmade. After participating in a neon bending workshop a few years ago, I learned that fabricators, rather than machines, use heat to bend and shape glass tubes from a sketch, then splice electrodes onto the ends of the glass tubes, seal the gas fill within.
**

10::
Illustrated steps:
https://www.asildastore.com/blogs/news/neon-signs

A neon salesman's sample case circa 2012
Photo: Reddit

Let There Be Neon color sample wall
Photo: Dallas Shaw

Thousands of colors are achieved by altering the combination of noble gases and glass tubes. Fabricators and neon salesmen take great pride in the variety of colors their shops can produce, and recipes are seldom shared or documented. Fabricators know that photography could not capture the mesmerizing colored light, so they created samples for their customers. We see a portable sample briefcase on the left, and a color sample installation on the right PAUSE
Fabricators use their knowledge of gas and glass properties to create the intended visual effect for the intended installation environment, often anticipating issues of aging and failure.

**

On the left we see an amazing relic from the era in which traveling salesmen could bring examples to interested business owners. Each of the short units in the case can be individually powered on, allowing customers to visualize single or a combinations of colors for their signs. On the right is the color sample wall at Let There Be Neon fabrication shop in New York City, which serves a similar purpose as the traveling case, and is also a stunning installation. PAUSE

Challenges for Conservation

Electronic components fail as gas-discharge components age
Brodie Food Mart in Austin, Texas becomes "Die Mart"
Photo: FourSquare

Like all technology-based works, gas discharge tubes are subject to the limited lifetimes of their electronic systems. As they age, color shifting and loss of luminance occur before they eventually fail.
like in this sign for Brodie Food Market where the left-half of the tubes have failed, taking on a hilarious, yet ominous message. If we consider the integrity of historical signs and artworks to be compromised when gas-discharge tubes inevitably fail or significantly change color, then their preservation lies in repair or replication.

For more hilarious sign fails: https://www.boredpanda.com/funny-burned-out-neon-sign-fails/?utm_source=google&utm_medium=organic&utm_campaign=organic

Restoration Case Study

A large section failed on *Work No. 957* EVERYTHING IS GOING TO BE ALRIGHT (2008), a permanent installation by Martin Creed at Scottish National Gallery of Modern Art
Photo: Instagram (image edited to enhance dark section)

Technician from Neon Circus fabrication studio repairs failed units
Photo: Neon Circus

I want to highlight 2 case studies comparing situations in which fabricators rely heavily on their experience and documentation to replace partial or wholly refabricate units. On the left we see a 13 meter-long gas-discharge tube installation by Martin Creed on the façade of the Scottish National Gallery of Modern Art in Edinburgh. At some point, a large section went dark, creating a gap in the message, ”everything is going to be alright”. Technicians from the same fabrication studio that created the work were responsible for its repair and restoration.

https://www.instagram.com/p/CJ4Sa9Ojqhf/?utm_source=ig_web_copy_link

**change headline
*make a disclaimer that it will take a while to get to the meat of my presentation

Restoration Case Study

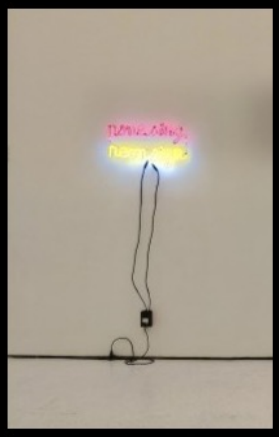
Restored state of *Work No. 957* EVERYTHING IS GOING TO BE ALRIGHT (2008) by Martin Creed. Photo: Andrei Dumitriu, taken January 2021

Technician from Neon Circus fabrication studio repairs failed units Photo: Neon Circus

I won't go into the details of their work This was a successful case where the fabrication studio kept exceptional records and were able to match the gas fill, glass tube composition, and transformer, creating a nearly seamless restoration which has lasted years.

Image:https://www.instagram.com/p/CJolrFOhrIa/?utm_source=ig_web_copy_link

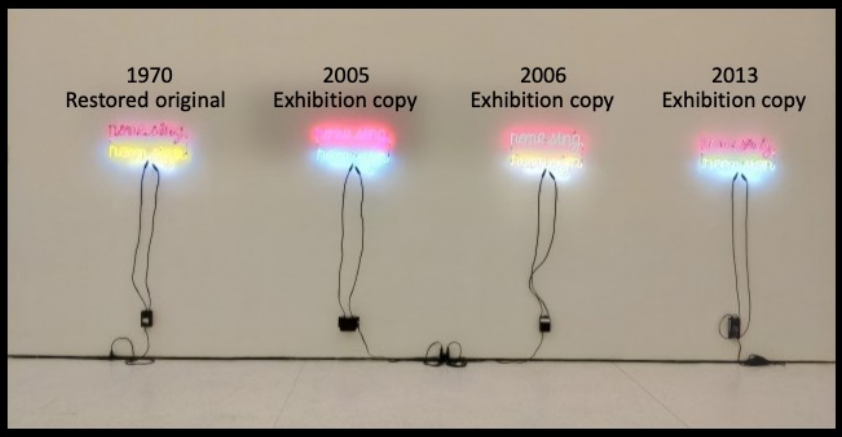
Replication Case Study



Bruce Nauman, *None Sing Neon Sign (*1970)
Restored Original
"Ruby-Red and Cool-White Neon"
Solomon R. Guggenheim Museum, New York
Photo: Dr. Hannelore Roemich

Now I'd like to highlight this case study which perfectly demonstrates how a lack of accurate documentation of gas-discharge tube materials creates challenges for replication.
When Bruce Nauman's original 1970 *None Sing Neon Sign* artwork noticeably shifted in color, the Guggenheim hired the artist's original fabricator to create a replacement exhibition copy.

Replication Case Study



Bruce Nauman, *None Sing Neon Sign (*1970)
"Ruby-Red and Cool-White Neon". Solomon R. Guggenheim Museum, New York
Photo: Dr. Hannelore Roemich

The most recent exhibition cleverly presented the restored original alongside subsequent exhibition copies to demonstrate the relation between colored light and gas discharge tube components. You can see from this photo that each unit produced significantly different colors and intensities of light. Through extensive research conducted by the Guggenheim and fabricator, the original 1970 materials were identified and a materially-faithful exhibition copy was created in 2013 seen on the far right. PAUSE START GOING SLOW

Artists develop significant relationships with fabricators because they are very intentional with their choice of materials based on colors and aging properties. So if our preservation goals prioritize the intended visual effect over maintaining original components that will eventually fail, we must be able to identify the materials used, and accurately document their intended colors to ensure materially and visually faithful light installations.

14:20

******

It should be noted that the original would have looked more like the 2013 exhibition copy before color shifting occurred.

*fix size of caption

Parameters affecting the color of gas-discharge tubes

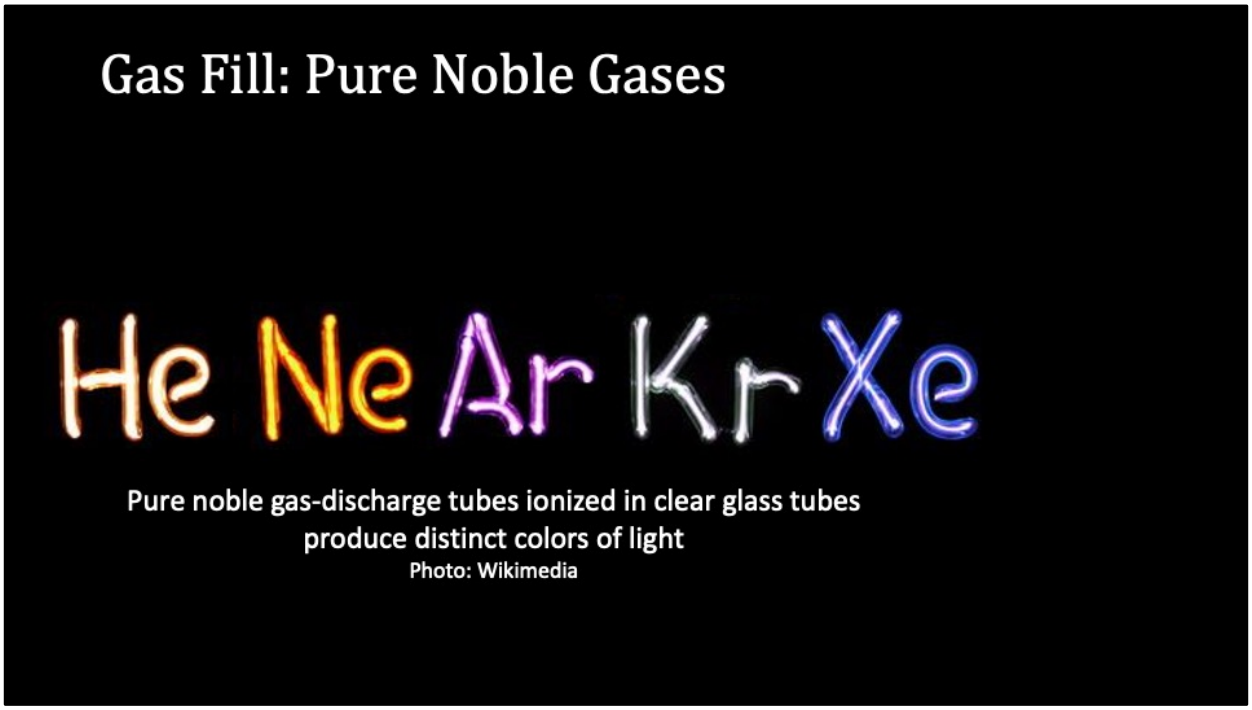
1. Noble gas type (aka 'gas fill')
2. Gas fill pressure
3. Glass tube composition
4. Glass tube diameter

I broke down the components of gas-discharge tubes into four parameters that affect the emitted color of light
PAUSE

Parameters affecting the color of gas-discharge tubes

1. Noble gas type (aka ‘gas fill’)
2. Gas fill pressure
3. Glass tube composition
4. Glass tube diameter

I focused on studying the effects of two variables: the gas fill and glass tube composition in order to create a baseline for understanding the materials responsible for a wide variety of colors of emitted light. I'll be devoting the rest of this presentation to identifying the effects of these two parameters.



I mentioned that noble gases are a class of chemically stable elements that can conduct electricity. We see here, noble gases that are sealed in clear glass tubes and electrified. Helium, neon, argon, krypton, and xenon produce distinct colors and intensities of light.
The gases in their pure state can be used on their own to produce these visual effects. but to achieve a much wider variety of colored light, they can be combined with one another,

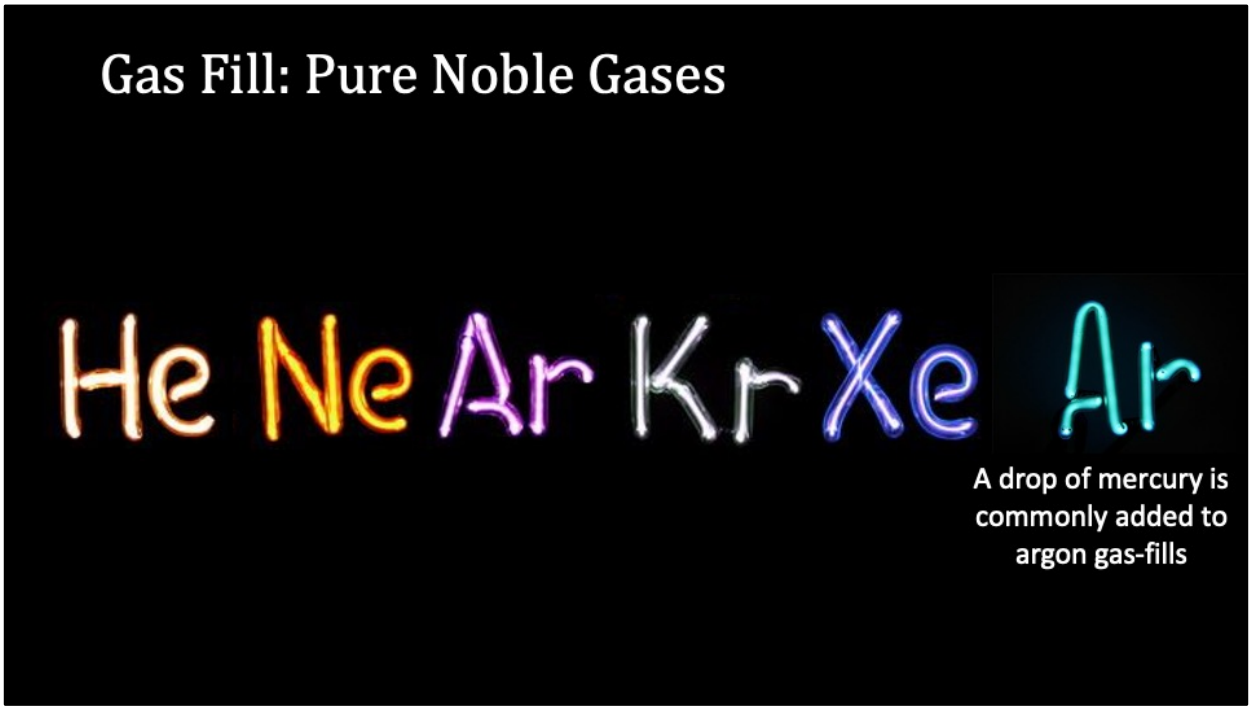
**

Why does a gas discharge tube have a certain color?
For the **gas** to emit radiation, its atoms must be in excited states. The **colors** just correspond to different frequencies of emitted radiation as the atoms return to their ground state. The electrical **discharge** through the **tube** produces the energetic electrons that collide with the atoms and cause excitation.

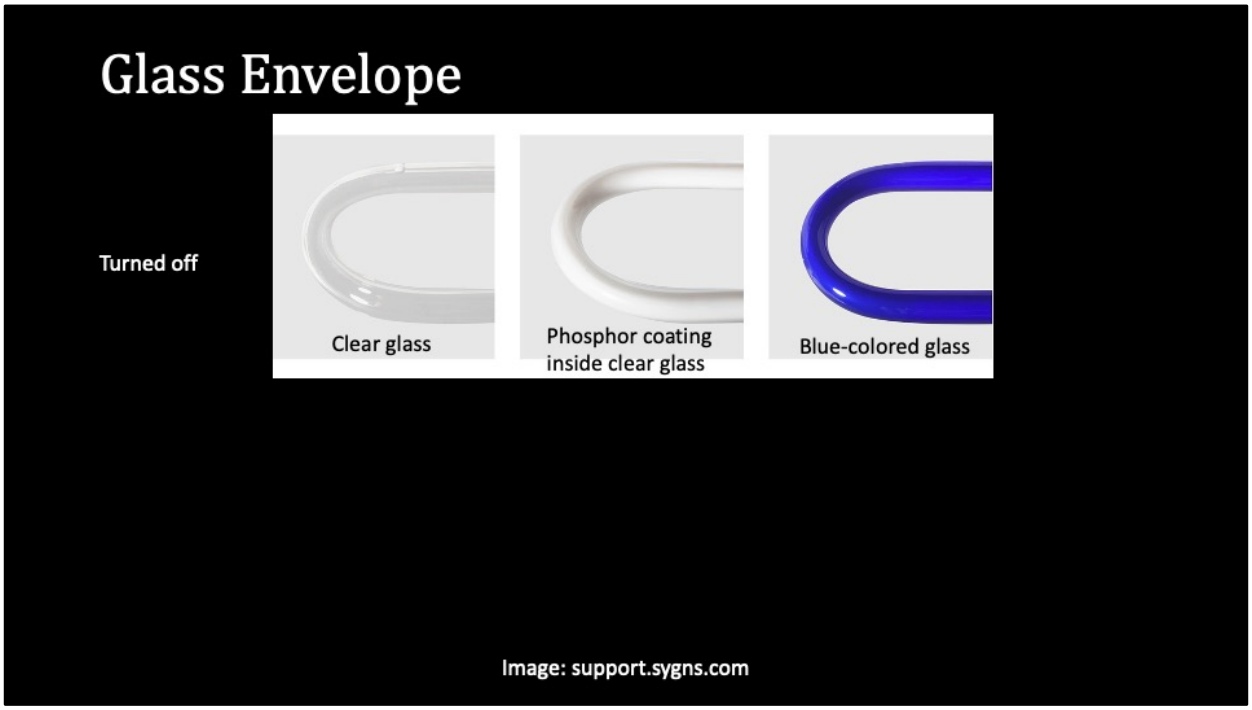
Gas mixtures are mainly used for outdoor installations to optimize light production in colder climates when temperatures drop. Its effects on color production have not been studied.

WHAT ABOUT RADON

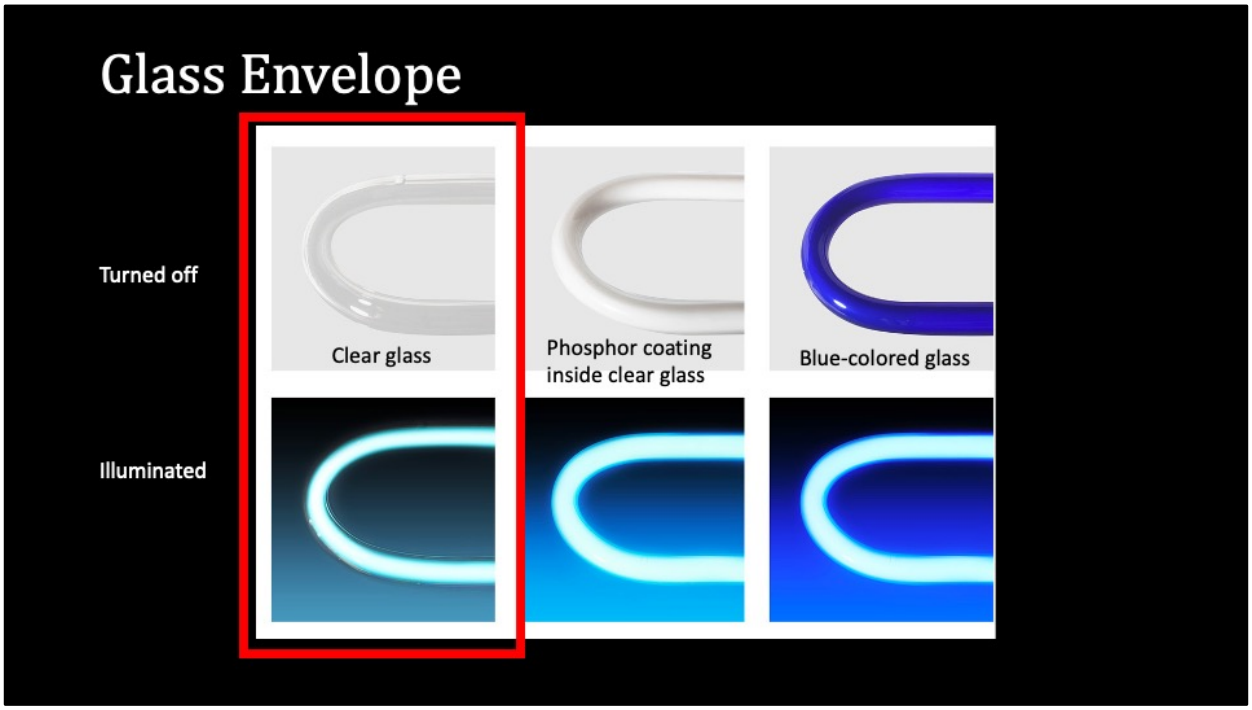
Radon, despite being a noble **gas**, is dangerously radioactive and its most stable isotope has a half-life of less than four days



or a drop of mercury, which is a very common addition to argon gas fills or CLICK

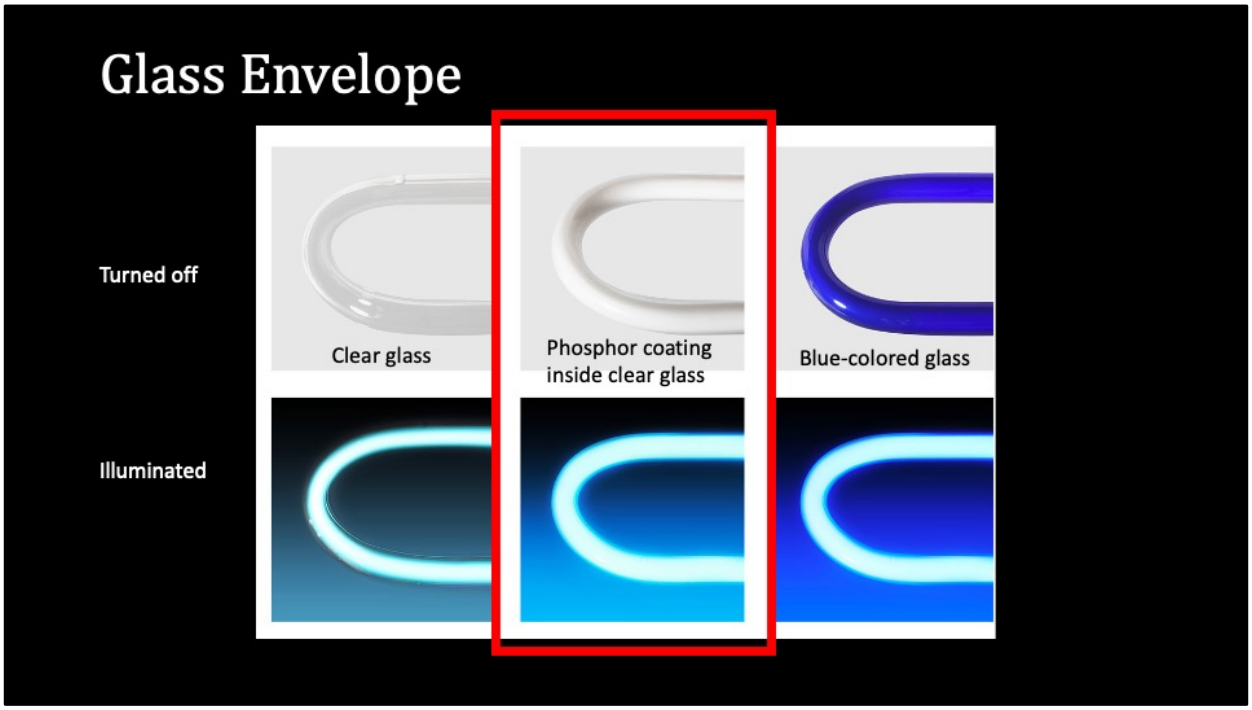


Or combined with treated glass tubes. Here we see 3 examples of different glass tube compositions. This row shows the units turned off, giving us and idea of what the glass tubes look like. Each of these compositions changes the color and intensity of light once they are powered on.

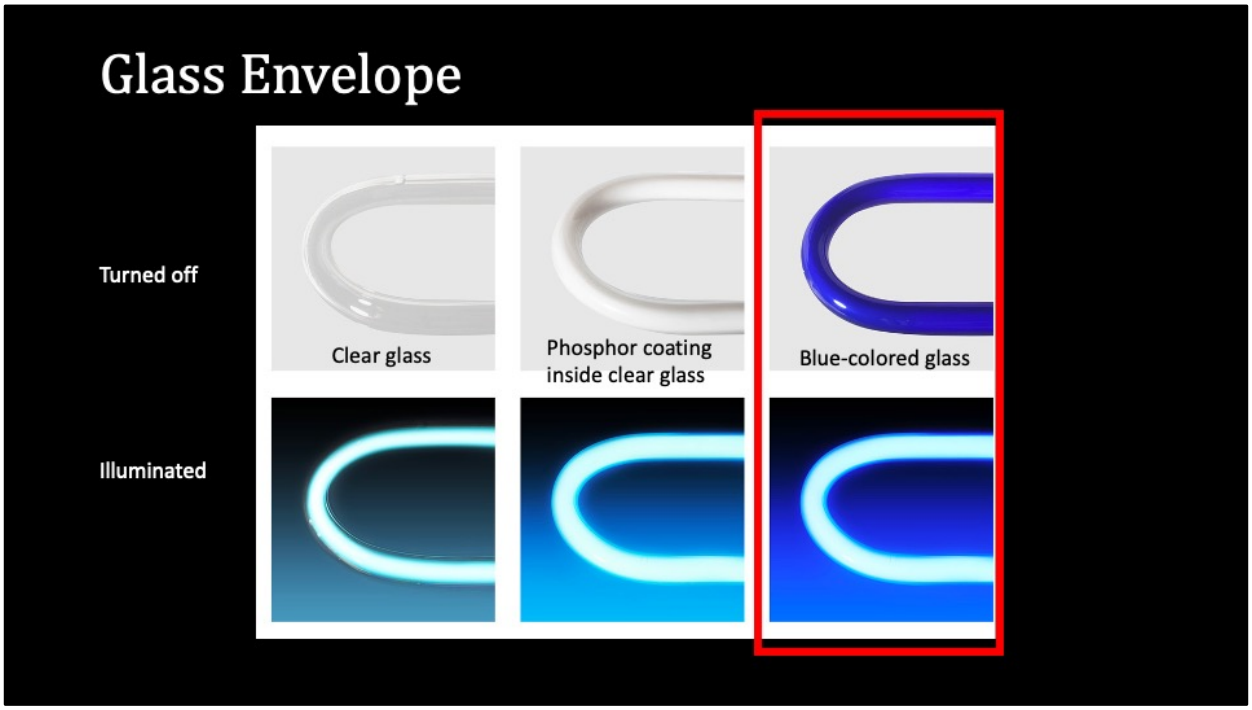


Here we see a pure argon mercury gas fill passing through a transparent tube, producing its distinct cool blue light

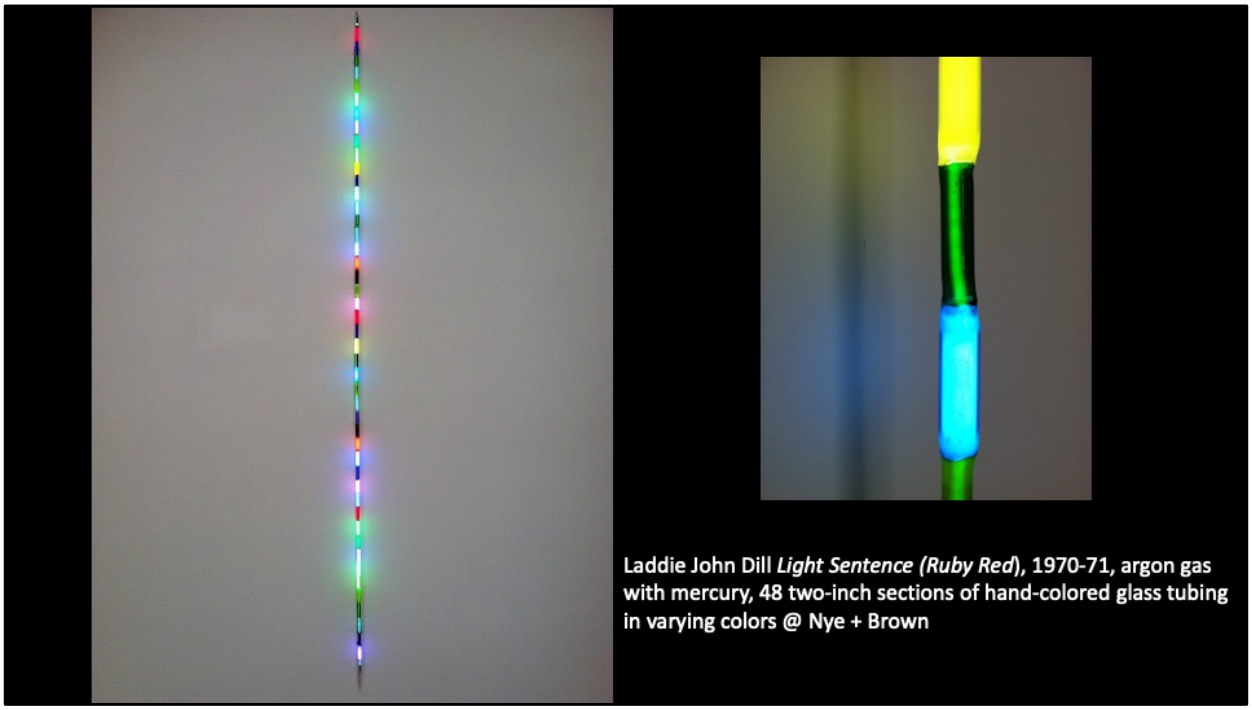
**Phosphor light emission: radiation/luminescence causes phosphors to fluoresce, In most cases, the emitted fluorescence has a longer wavelength, and therefore lower energy, than the absorbed radiation. where fluorescent coatings are used to convert short-wavelength UV light or blue light into longer-wavelength yellow light, thereby mimicking the warm light of energy-inefficient incandescent lamps.



In the center features a phosphor coating on the inside of a clear glass tube. When powered on the color is a similar cool blue, but the light is more intense from the vaporized mercury causing phosphors to fluoresce.

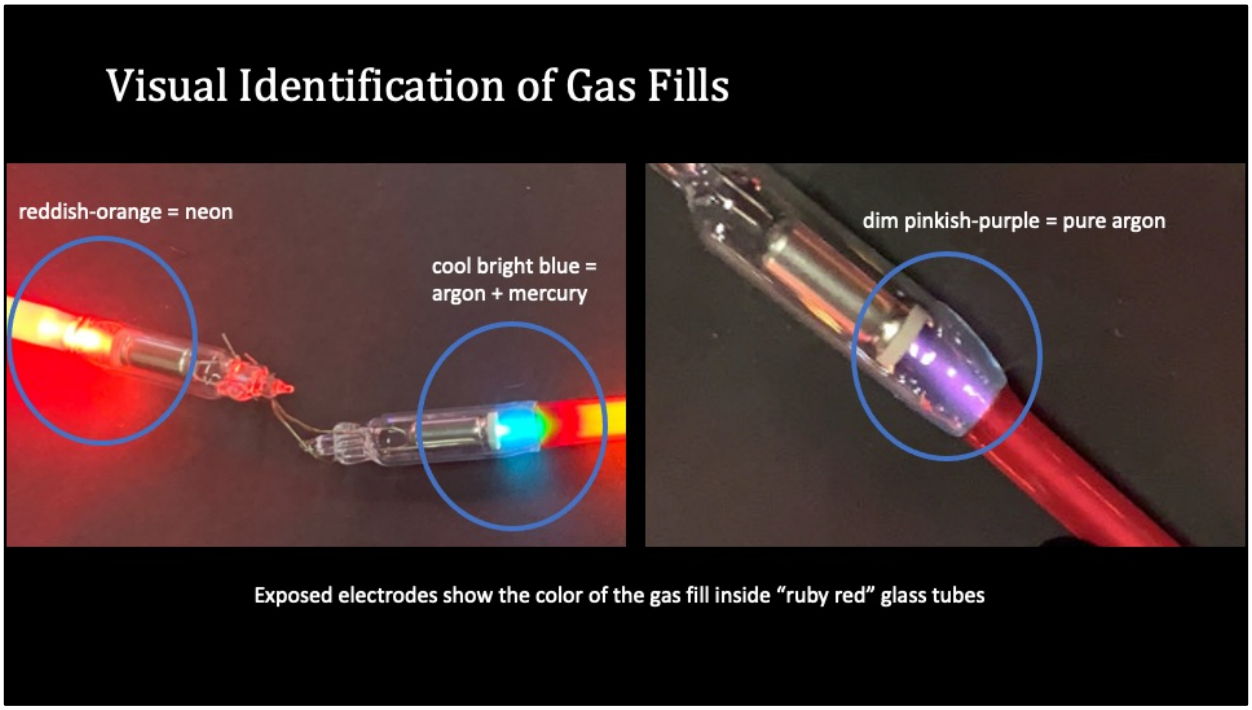


And last, we see a blue glass tube that was colored with metal oxides and coated with phosphors inside which shifts the cool bright blue light to a deep cobalt blue. PAUSE



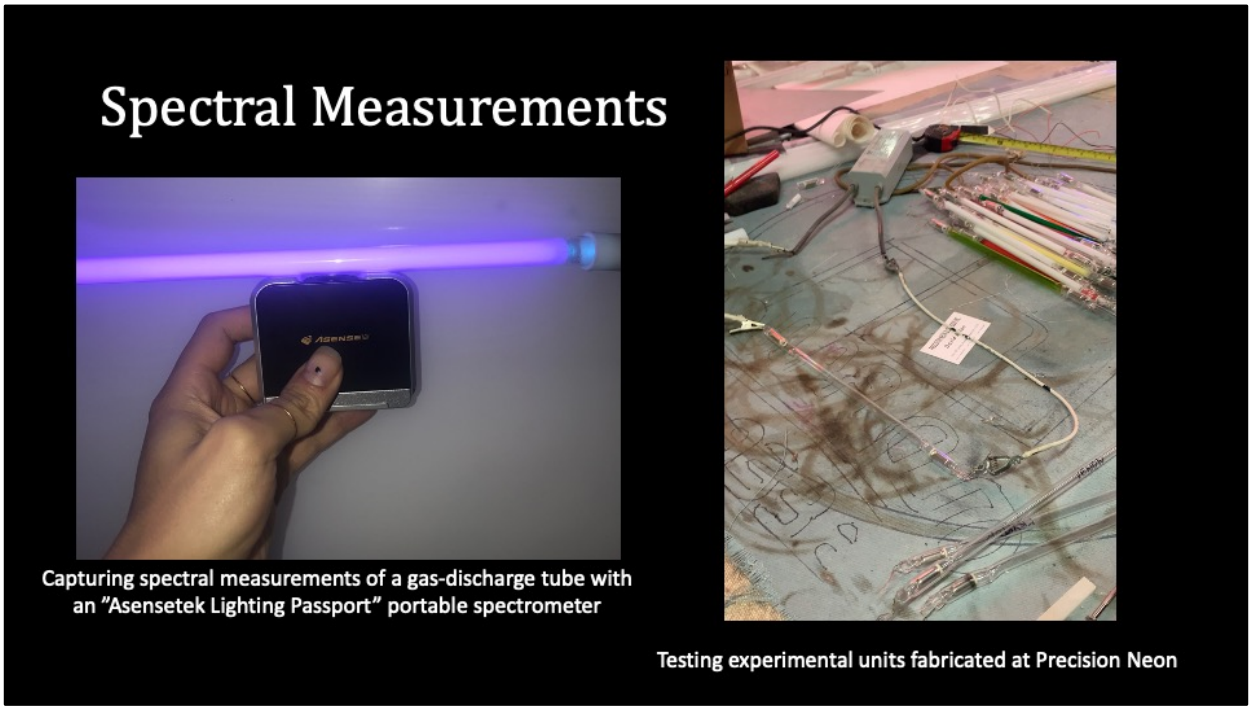
This artwork by artist Laddie John Dill perfectly demonstrates how the the glass composition affects the visual appearance of a gas fill: When the light passes through, each of the segments produces a completely different visual effect. We can use visual examination and various analytical techniques to identify the glass composition, but how do we detect the composition of an invisible gas fill?

CUT?17

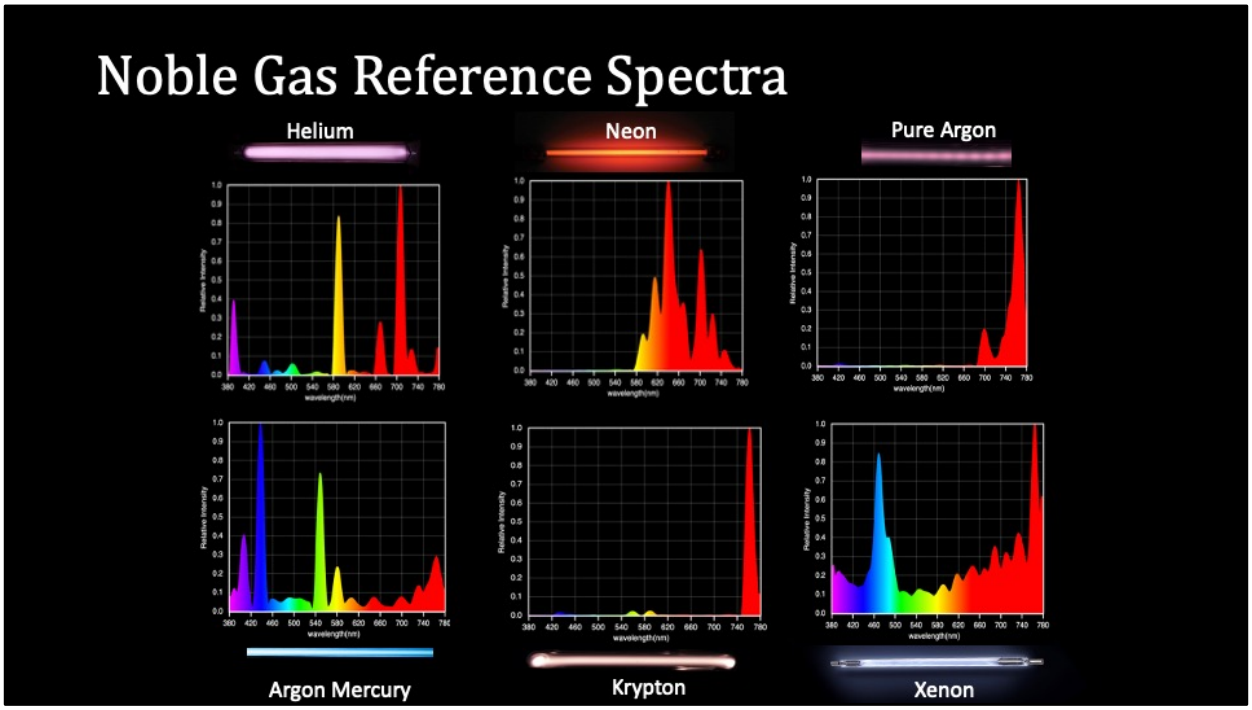


Like many material identification techniques, there are practical ways and highly technical ways. CLICK You can do some reliable gas identification by looking at the color of the ionized gas at the ends of the tubes CLICK nearest the electrodes if they are accessible. Most gas fills are either neon, pure argon, or argon mercury. the clear glass around the electrodes exposes the characteristic reddish orange of neon gas, cool bright blue from an argon mercury fill, and a dim pinkish purple produced by pure argon

However, visual identification can be unreliable when more than one gas is used in a single unit, and when uncommon gas pressures are used.



So to be sure of what gas fills you have, i developed this technique using a handheld spectrometer to visualize the light in a way that reliably distinguishes gas fills. I worked with neon fabrication extraordinaire David Ablon in Brooklyn to create 60+ experimental tubes, each representing a common recipe used in the studio. We connected each unit to the transformer, CLICK powered it on, and took measurements with this spectrometer that connects to my iphone via bluetooth

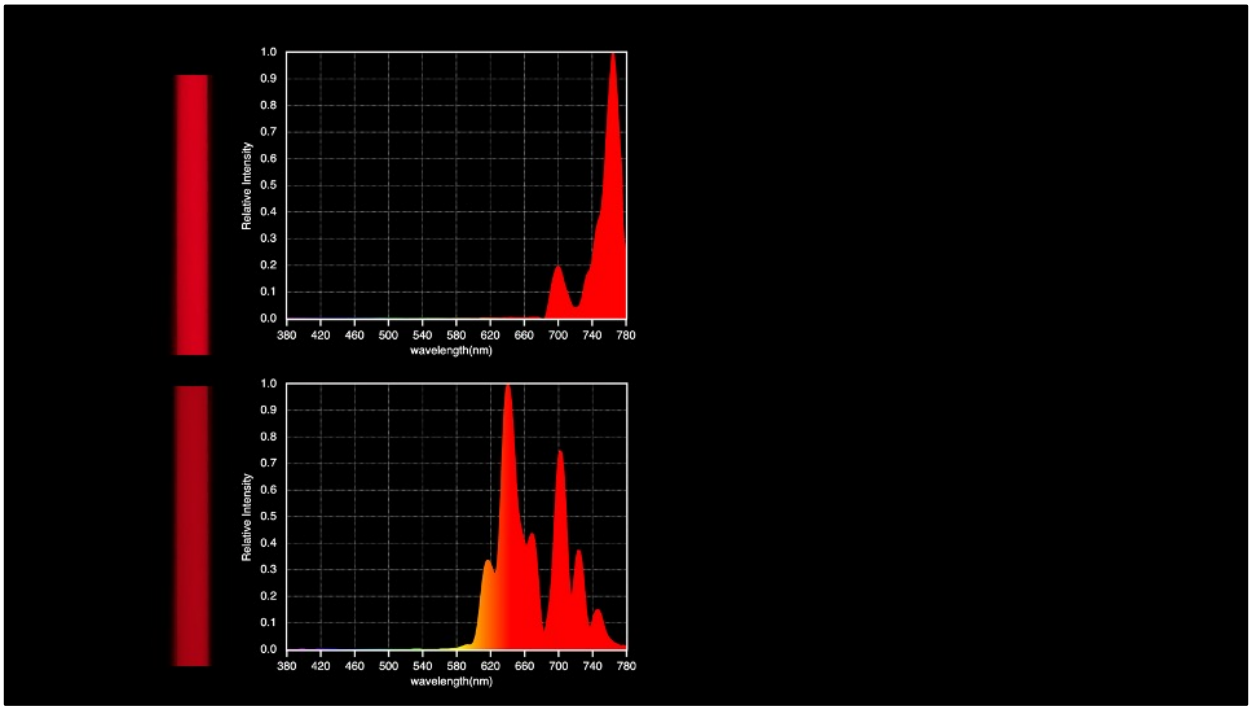


Spectrometers produce these spectral power distributions by measuring the energy levels at each wavelength in the visual light spectrum. I like to think of **spectral power distribution**s a kind of “fingerprint” of a light source, as it is the key to how all light sources render colors. Here are the pure noble gases ionized in clear glass, and as you can see, their spectra have distinct shapes and produce peaks at distinct wavelengths, allowing us to identify the intangible, imperceptible gas fill sealed in a glass envelope.

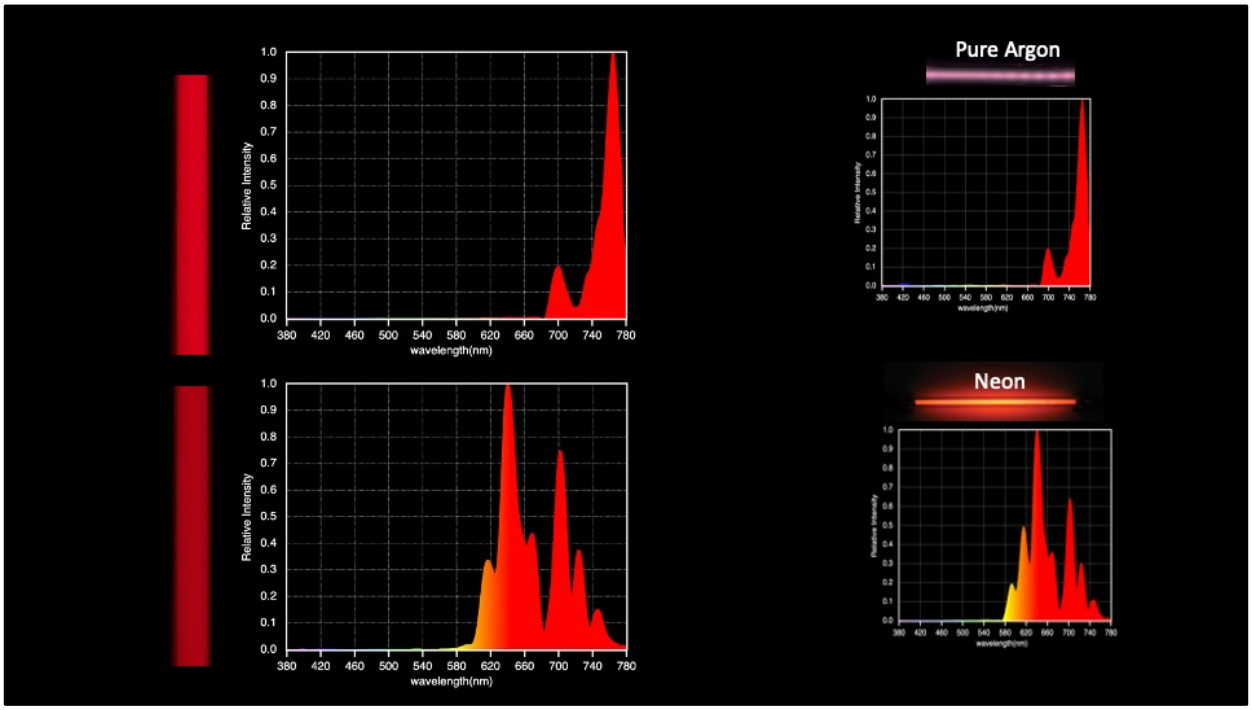
PAUSE
1930

This technique becomes incredibly valuable for identifying tubes used in artworks or historical signs for documentation and preservation purposes. Certain recipes are chosen to achieve exact colors, and each come have their own aging properties. Here we see two illuminated red tubes that are produced by different recipes but are virtually indistinguishable.

Images from https://www.abitechsupply.com/shop/tecnolux-118u-ruby-red-neon-uncoated/
Ruby red colorant:by precipitation of nanometer sized colloides (so-called *striking glasses*[1] such as "gold ruby"[3] or red "selenium ruby")



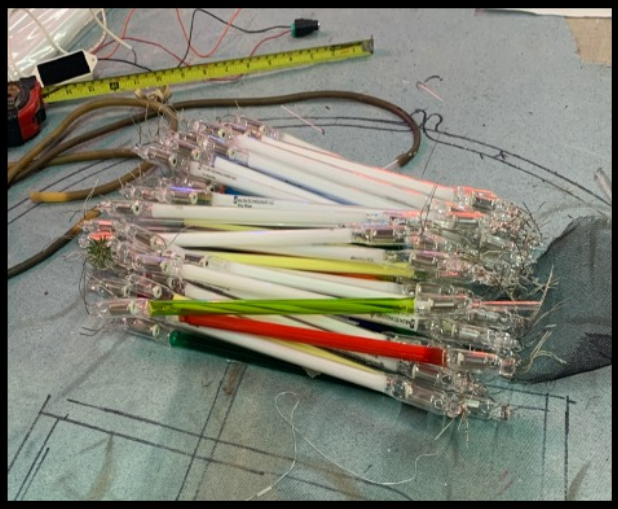
The differences become evident when we look at the spectral power distributions. Here we see distinct spectral peaks produced by each tube demonstrating that there are two different gas fills.



If we compare these spectra to the noble gas references I created we see the distinct pure argon distribution produced by the top tube and the distinct neon spectral distribution on the bottom.
So if one of these tubes were in an artwork or a sign that required replacement in the future, we are able to capture spectral power distributions and identify the gas fill before it fails

*Red glass tube filters wavelengths below 600 which is why we don't see the peak at 590 in the neon experimental tube

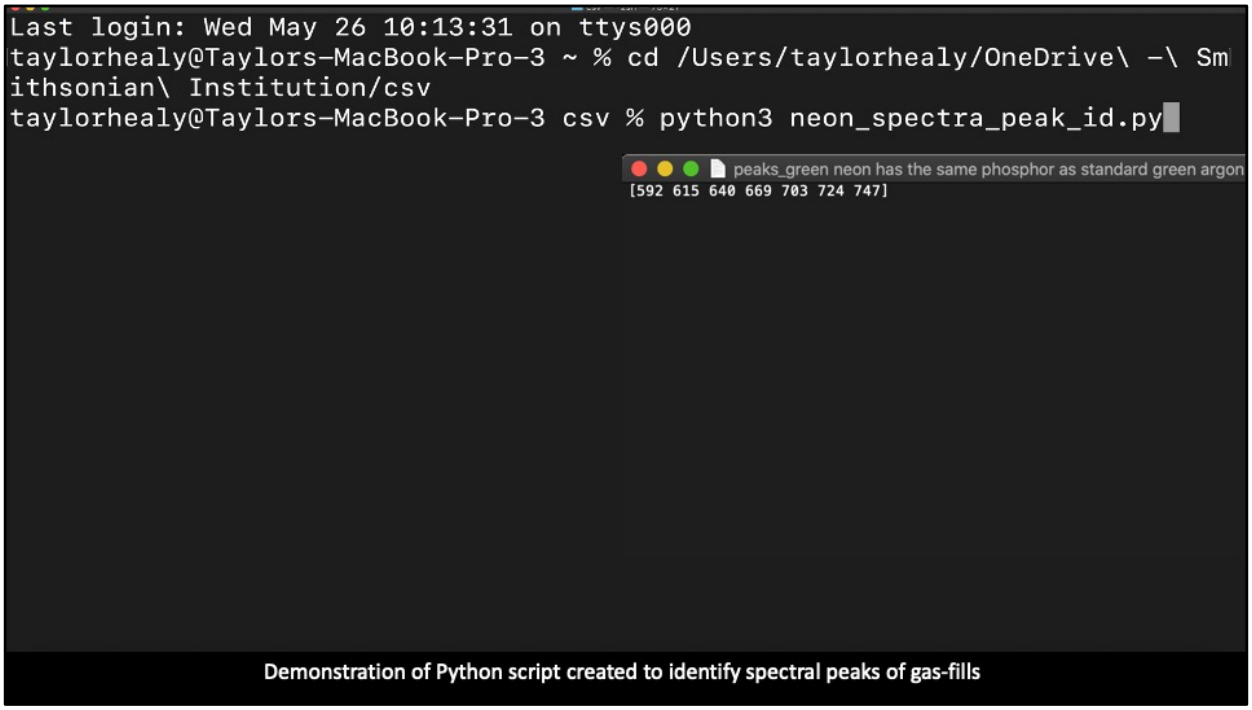
When life hands you a pandemic, you make a Python script



Dozens of experimental gas-discharge units

This was just one example of comparisons that I was able to make by studying the spectral measurements of the experimental units. There was so much data to parse through with the other 60 experimental units.

Like everyone else, the pandemic limited my access to resources, and caused major delays in this project. I took a coding workshop last summer, which inspired me to create my own tools for analysis. I had over 60 units to analyze and decided to spend my time making a program that was scalable and sharable.



Demonstration of Python script created to identify spectral peaks of gas-fills

CLICK PLAY By using a python module called pyplot, I cleaned up the raw data of each unit and automated the identification of peaks and their corresponding wavelengths on a graph. CLICK ARROW Then I extracted those peak wavelengths and wrote them to a text file for each experimental tube. From a master list, I am able to compare the peak wavelengths of all experimental units. I will spend time making this tool more user-friendly and share the data I created from the experimental units to anyone interested.

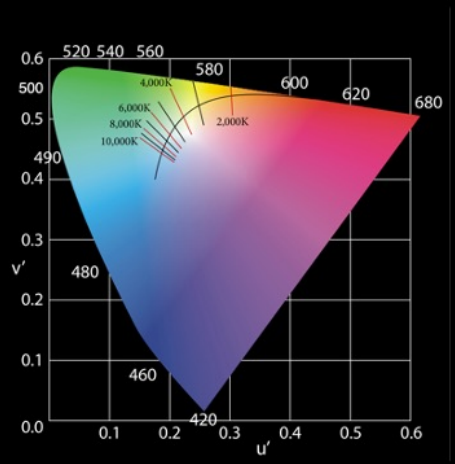
Documenting Color

Photo-documentation of color is unreliable

So now we know how to identify what is in the glass tubes, how do we characterize and document colored light that they produce? Photography fails in capturing accurate color and the naked eye fails in detecting colorshifting over time.
25:00

Documenting Color

Photo-documentation of color is unreliable.
Use a spectrometer to measure chromaticity

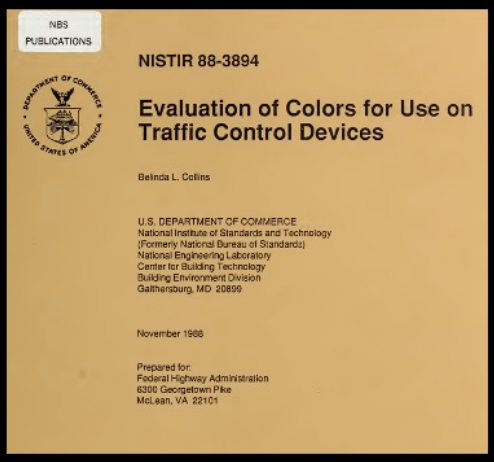


CIE LUV 1976 Color Space

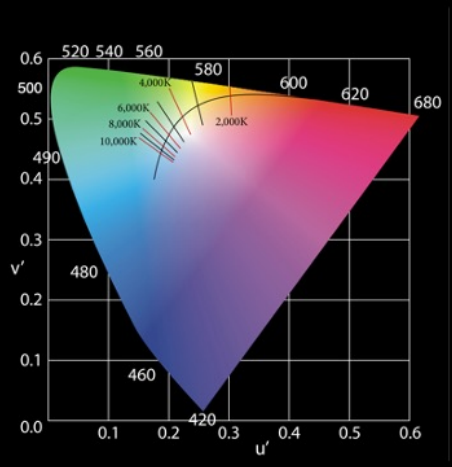
We can use another spectral measurement: **Chromaticity**, which is an objective specification of the quality of a color regardless of its luminance. Chromaticity is measured as coordinates in a standardized color space.

**I actually chose the CIE LUV (1976) because it improved the uniformity with chromaticity

Documenting Color



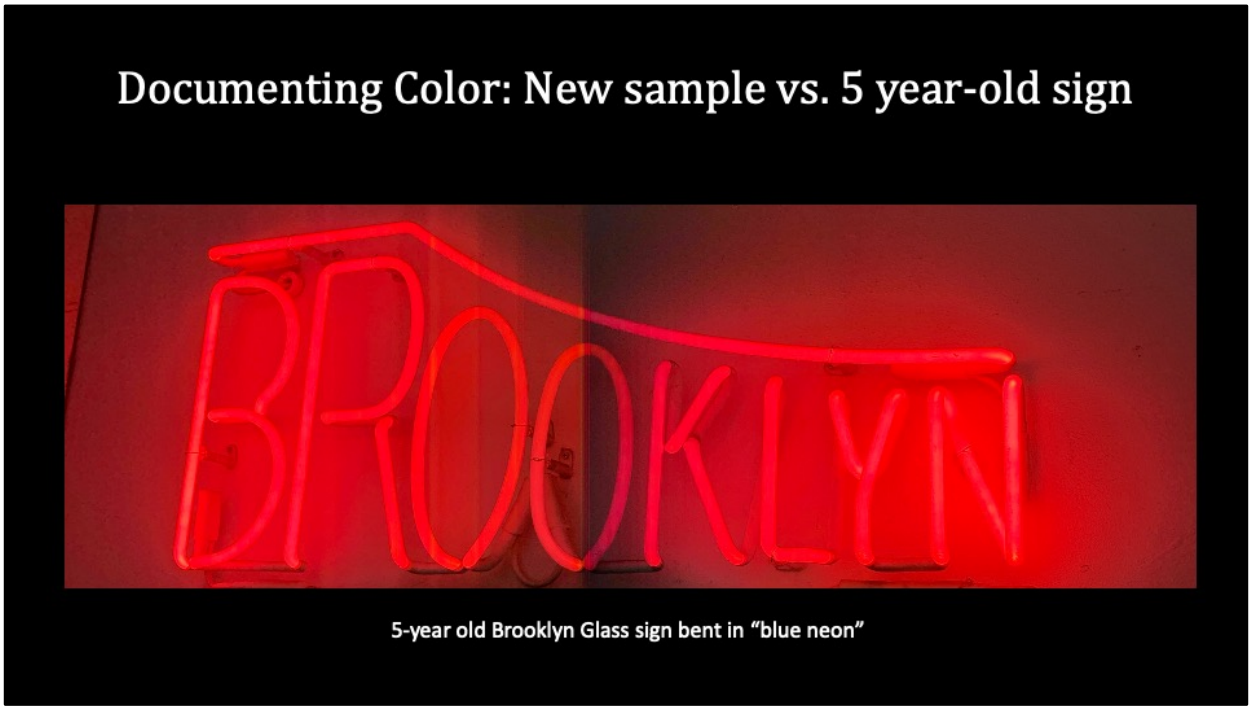
National Bureau of Standards uses chromaticity thresholds to regulate traffic light colors



CIE LUV 1976 Color Space

This is actually how the department of transportation and National Bureau of standards control the color of traffic lights.

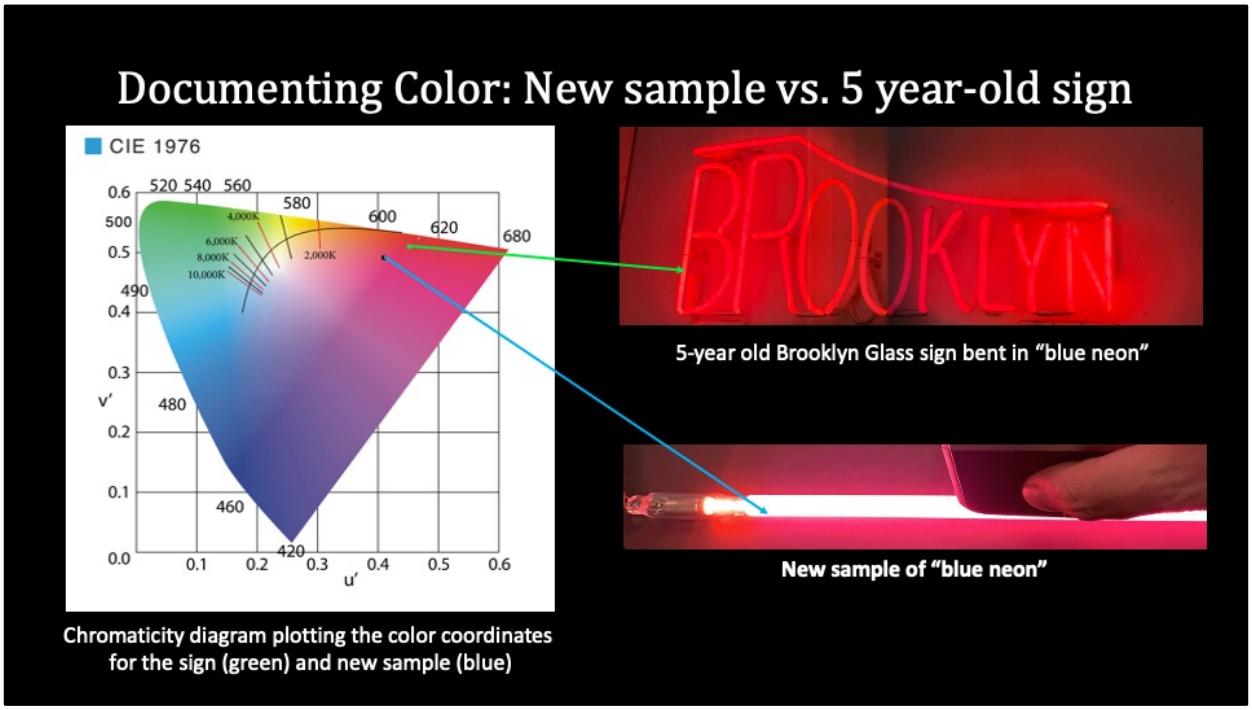
CHANGE
IMAGE



I decided to test this out on an aged neon sign and a new sample experimental unit. Long time employees of Brooklyn Glass have noticed that the color of this entrance sign has shifted.

**

In addition to documenting color shifting, chromaticity can also be used to make sure that replacement units in artworks produce the same color as an original.



Let's ignore the color of these images and instead use chromaticity to document the colors. We can actually quantify the sign's color shifting with the captured coordinates on the chromaticity diagram. We can see that the color from the sign is a more red than the new sample which is reddish pink. This is valuable information to have now, as the sign will continue to shift and we an take more measurements in the future and actually plot the colorshifting which has never been done!

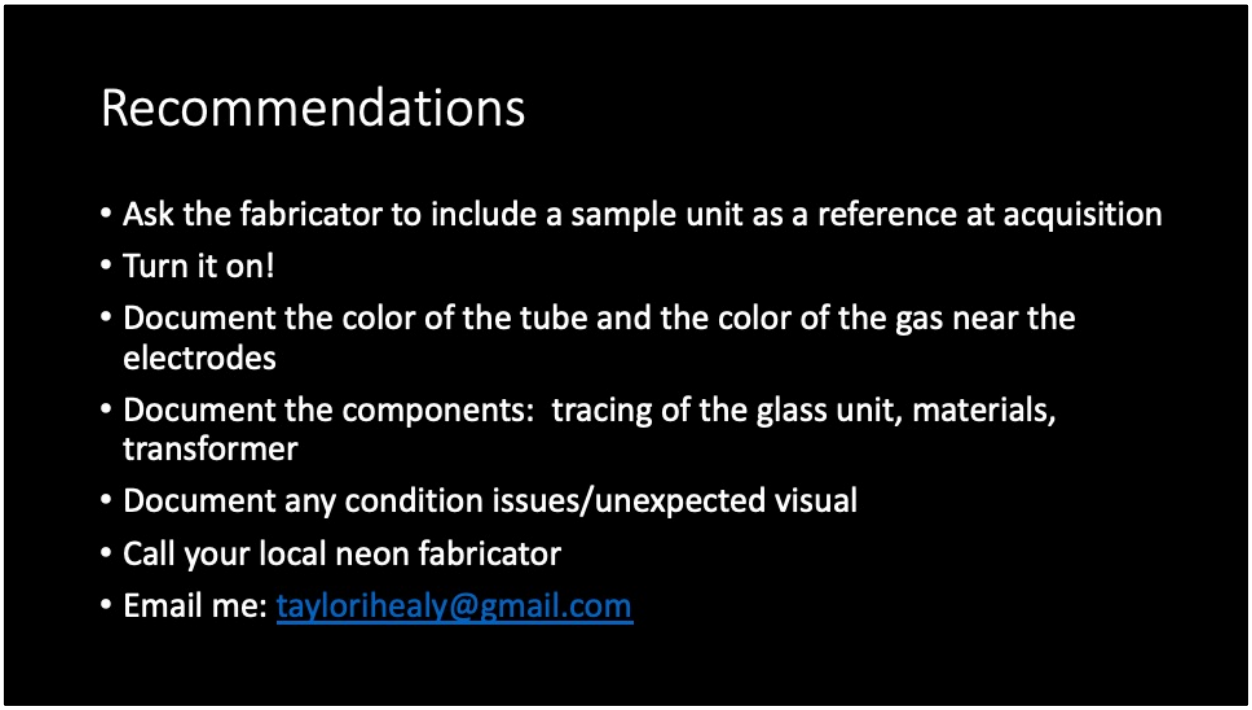
In addition to documenting color shifting, chromaticity can also be used to make sure that replacement units in artworks produce the same color as an original. And we can set thresholds for when units should be replicated.

**MANIPULATE IMAGE

Using a high-voltage neon tube tester (spark coil) to illuminate tube units
Screenshot: Youtube.com

Neon tube tester
Photo: ebay.com

Now all of these identification tips and color characterization come with a huge disclaimer: the tubes need to be intact and functional! In the event that yours doesn't turn on,
for under $20 you can buy this spark coil that can provide enough power to your tube in the event that the electrode leads or transformer have failed. Basically what you do is…



In closing, I wanted to share some recommendations that might help you identify the materials used in your units. It is ideal to document these at acquisition or just after fabrication, but it is still useful to capture these as soon as possible.

EMAIL ME : email address

**re-order

I'd like to thank the following foundations, advisors, and experts for supporting this research and enriching my education at NYU CLICK

And a super special shout out to David Ablon CLICK at Precision Neon for his immense enthusiasm for my research and for sharing his knowledge with me

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